

Universidad de Cantabria - Doctoral Programme

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Lectures (8 x 2h)

These 8 lectures are structured in order to provide information about the catalysts, their preparation methods, catalytic reactors and their utilization in various chemical technological processes. During the practical work the students will design conceptual flow sheets based on the knowledge of thermodynamics, kinetics and catalysis for several case studies.

Lectures 1 – What is catalysis

Definitions

Overview of catalytic process

Industrial importance

Shapes of catalysts

Environmental catalysis

Homogeneous vs heterogeneous catalysis

Design principles: activity, selectivity, stability

Catalysis is nano!

E-factor

Lectures 2-3 Materials

Classification of catalysts

Catalysts shapes

Morphology vs reactor

Engineering catalyst preparation

Description of supports

Silica, alumina, carbon, carbon nanofibers

Structured materials: monoliths, fibers, carbon cloths

Lectures 4-5- Kinetics and mass transfer

Activity, selectivity, kinetic laws

Relationship between kinetics and mechanism

Quasi-equilibrium, rate limiting steps

Deactivation, causes for deactivation

Fighting deactivation: catalyst and reactor levels

Diffusion, external and internal diffusion

Calculation of mass transfer coefficients

Effectiveness factor

Heat transfer and mass transfer

Mass transfer in three phase systems

Lecture 6 -Reactors

Reactor types

Selection of reactors

Batch, tubular reactor

Requirements for industrial catalytic reactors

Two phase and multiphase reactors

Trickle bed reactors, slurry reactors.

Reactors with structured catalysts

Heat management

Basics of reactor modelling- mass balances

Lectures 7 -8 Process development and case studies

Process development

Approach to industrial processes

Process analysis

From concept to a flow chart

Reactor selection principles

Multiphase reactor selection

Selection of reactors

Examples in refinery applications: catalytic cracking, reforming

Examples in bulk chemicals production: natural gas steam reforming, ammonia synthesis, sulphuric acid production, partial oxidation,

Process intensification

Seminar (1h plus debate)

“Challenges in developing catalysts for cleaning exhaust gases from diesel engines: HC-SCR of NO_x”

Different types of aftertreatment for diesel engines will be discussed. NO_x traps, urea and hydrocarbons selective catalytic reduction.

Individual Research Projects

Proposed structure:

Based on the brief description of a process (thermodynamics, kinetics, catalysis) the task will be to develop a conceptual flow scheme addressing the feed treatment, reactor section and separation section.

The conceptual flow schemes will be presented orally, discussed and compared with the current industrial practice.